Relationship Between High-Sensitivity Cardiac Troponin I and Blood Pressure Among Young and Healthy Adults

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BACKGROUND
The aim of this study was to evaluate the relationship of cardiac troponin (cTn) levels with conventional and ambulatory blood pressure (BP) in young and healthy adults.

METHODS
We performed a population based cross-sectional analysis among 2,072 young and healthy adults aged 25–41 years free of cardiovascular disease and diabetes mellitus. cTnI was measured using a highly sensitive (hs) assay. The relationships of high sensitivity cardiac troponin I (hs-cTnI) with office and 24-hour BP were assessed using multivariable regression analyses.

RESULTS
Median age was 37 years and 975 (47%) participants were male. hs-cTnI levels were detectable in 2,061 (99.5%) individuals. Median (interquartile range) hs-cTnI levels were 0.98 (0.71; 1.64) ng/L among men and 0.48 (0.33; 0.71) ng/L among women. Systolic BP, but not diastolic BP, gradually increased across hs-cTnI quartiles (118, 120, 121, and 122 mm Hg for conventional BP; $P = 0.0002$; 122, 123, 124, and 124 mm Hg for 24-hour BP, $P = 0.0001$). In multivariable linear regression analyses, the β estimates for systolic BP per 1-unit increase in log transformed hs-cTnI were 2.52 for conventional BP ($P = 0.0001$); 2.75 for 24-hour BP ($P < 0.0001$); 2.71 and 2.41 ($P < 0.0001$ and $P = 0.0002$) for day and nighttime BP, respectively. There was a significant relationship between hs-cTnI and the Sokolow–Lyon Index (odds ratio (95% confidence interval): 2.09 (1.37; 3.18), $P < 0.001$).

CONCLUSION
Using a hs assay, hs-cTnI was detectable in virtually all participants of a young and healthy population. hs-cTnI was independently associated with systolic BP and left ventricular hypertrophy.

Keywords: ambulatory blood pressure monitoring; blood pressure; cardiac troponins; hypertension; population based.

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Elevated blood pressure (BP) is one of the most prevalent cardiovascular risk factors[1] and strongly associated with the occurrence of major cardiovascular events.[2–5] In this context, BP-induced myocardial damage is one of the best studied consequences of elevated BP, and by itself an important predictor of cardiovascular outcomes.[6,7] The potential value of biomarkers to detect BP-induced left ventricular hypertrophy has been described previously.[8,9]

Cardiac troponins (cTn) are released from myocardial cells in case of overt myocardial injury and can be easily quantified in this context.[10] However, current cTn assays have a variable sensitivity to detect cTn levels in lower risk populations.[11] For example, a prior population-based study among middle-aged individuals found detectable high-sensitivity (hs) cTnT levels in only 25% of the population.[12] Despite this limitation, a significant association with left ventricular hypertrophy has been observed in this study, underscoring the great potential of cTn for this purpose.[12] On the other hand, one study found that 82.6% of men and 67.0% of women had detectable cTnI levels in a middle-aged population, providing evidence that quantification of cTn levels is feasible in the majority of individuals.[13]

Although the clinical utility to detect low levels of cTn in healthy population samples is currently unknown, hs-cTn assays may nevertheless be very useful to improve our mechanistic understanding of cTn turnover and its associations with cardiovascular risk factors. In the current study, we therefore aimed to elucidate the distribution of cTn levels in a young and healthy population using a state-of-the-art high-sensitivity cardiac troponin (hs-cTnI) assay.[11]

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We then sought to assess the relationships of hs-cTnI with conventional and ambulatory BP in the same sample population.

METHODS

Study participants

Starting in 2010, all inhabitants of the Principality of Liechtenstein aged 25 to 41 years were invited to participate in the ongoing genetic and phenotypic determinants of BP and other cardiovascular risk factors (GAPP) study. Individuals with a body mass index >35 kg/m^2, known cardiovascular disease, known sleep apnea syndrome, renal failure, current intake of antidiabetic drugs, or other severe illnesses were excluded. The detailed design and methodology of the GAPP cohort have been described previously.[14] Of the 2,159 participants with available hs-cTnI measurements, 87 individuals (4.0%) with no or insufficient ambulatory BP information as defined below were excluded, such that 2,072 participants remained in the current analyses. The study protocol was approved by the local ethics committee, and informed written consent was obtained from each participant.

BP assessment

After at least 5 minutes of rest, three conventional BP measurements were obtained using a validated oscillometric device (Microlife BP3AG1, Microlife AG, Widnau, Switzerland). For this study, conventional BP was defined as the mean of the second and third BP measurement. Ambulatory 24-hour BP monitoring was performed using a validated automatic device (BR-102 plus, Schiller AG, Baar, Switzerland). BP was obtained every 15 minutes from 07.30 to 22.30 and every 30 minutes during nighttime. If participants had less than 80% of valid BP measurements, the BP recording was repeated whenever possible. Day and nighttime BP were defined according to individually completed diaries. Individuals with <10 valid daytime or <5 valid nighttime measurements were considered to have insufficient ambulatory BP information and were excluded from this study.

Assessment of high-sensitivity Troponin I and other biomarkers

A fasting venous blood sample was obtained from each participant and stored immediately after centrifugation at −80 °C. hs-cTnI was assayed from frozen EDTA plasma samples using a single-molecule counting technology (Erenna Immunoassay System, Singulex, Alameda, CA) with a limit of detection of 0.04 ng/L,[15] and intra-/inter-assay coefficients of variation of 6%/6% at a hs-cTnI concentration of 8.3 ng/L, and 8%/9% at a hs-cTnI concentration of 79.7 ng/L. Eleven individuals with undetectable hs-cTnI levels in our sample were assigned a hs-cTnI value of 0.04 ng/L.

The measurement of other biomarkers used in this analysis has been described in detail previously.[14] Glomerular filtration rate was estimated using the formula of the chronic kidney disease epidemiology collaboration.[16]

Assessment of left ventricular hypertrophy

A standardized 12-lead resting electrocardiogram (ECG) was obtained in every participant using a validated device (Schiller AG). Sokolow–Lyon Index (SLI) was calculated as the sum of the higher S-Wave in lead V1 or V2 and the higher R-Wave in lead V5 or V6. A SLI >3.5 mV was defined to indicate left ventricular hypertrophy.[17]

Assessment of other study variables

Information about personal, medical, lifestyle, and nutritional factors were evaluated using standardized questionnaires. Smoking status was self-assessed as current, past, or never. Physical activity was evaluated with the validated individual physical activity questionnaire.[18] Regular physical activity was defined as vigorous physical activity >180 minutes per week. Weight and height was measured in a standardized manner by trained study nurses. Body mass index was calculated as body weight in kilogram divided by height in meters squared.

Statistical analysis

Baseline characteristics were stratified by sex-specific hs-cTnI quartiles. Distribution patterns for continuous variables were checked using skewness, kurtosis, and visual inspection of the histograms. Baseline characteristics of continuous variables were presented as mean ± SD or median (interquartile range), and compared using analysis of variance or Kruskal–Wallis tests, as appropriate. Categorical variables were compared using chi-square tests.

Multivariable linear regression models were constructed to compare the β-coefficients of various systolic and diastolic BP indices (conventional BP, 24-h BP, daytime BP, and nighttime BP) across sex-specific quartiles of hs-cTnI. Because the observed associations were approximately linear, we performed additional analyses with hs-cTnI as a continuous variable as the predictor of interest. As the distribution of hs-cTnI levels was not normal, this variable was log-transformed for all continuous analyses. All analyses were adjusted for a predefined set of potential confounders including age, sex, body mass index, current smoking, high density lipoprotein cholesterol, low density lipoprotein cholesterol, hemoglobin A1c, glomerular filtration rate, antihypertensive treatment, and physical activity.

Multivariable logistic regression analyses were performed to correlate sex-specific quartiles of hs-cTnI with a positive SLI (SLI >3.5 mV) as a marker of left ventricular hypertrophy. In addition to adjusting these models for the same covariates indicated above, we also included plasma levels of N-Terminal B-type natriuretic peptide (NT-pro BNP) in these models.

Vigorous physical activity is a known determinant of left ventricular mass,[19,20] and may therefore modify the relationship between BP and hs-cTnI. We therefore constructed additional multivariable regression analyses stratified by physical

activity. Formal interaction tests between hs-cTnI and physical activity were performed in the nonstratified models.

Linear trends were calculated across sex-specific quartiles of hs-cTnI. Categorical variables were entered in the multivariable models using binary indicator variables. All statistical analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC). A *P*-value of <0.05 was prespecified to indicate statistical significance.

RESULTS

Baseline characteristics of the 2,072 participants according to sex-specific quartiles of hs-cTnI are presented in Table 1. hs-cTnI levels were detectable in 2,061 (99.5%) individuals. Median (interquartile range) hs-cTnI levels were 0.98 (0.71; 1.64) ng/L among men and 0.48 (0.33; 0.71) ng/L among women. Quartile-specific medians (interquartile range) were 0.56 (0.46; 0.63), 0.85 (0.78; 0.91), 1.25 (1.13; 1.41), and 2.58 (1.97; 4.28) for men; and 0.24 (0.18; 0.28), 0.40 (0.37; 0.43), 0.56 (0.51; 0.62), and 1.11 (0.84; 1.86) for women. The 99th percentile of hs-cTnI was 15.76 ng/L in men and 6.06 ng/L in women, respectively. Participants with higher hs-cTnI levels were less often current smokers ($P < 0.0001$) and more often physically active ($P < 0.0001$). High density lipoprotein cholesterol levels increased and glomerular filtration rate decreased across quartiles of hs-cTnI ($P = 0.002$ and $P < 0.0001$, respectively). There were nonlinear differences across hs-cTnI quartiles for age ($P = 0.002$) and body mass index ($P < 0.0001$), as shown in Table 1.

BP and high-sensitivity cTnI

Systolic and diastolic BP levels across quartiles of hs-cTnI are shown in Figure 1. We observed a significant increase in mean systolic BP for all BP indices, whereas no relationship was seen between hs-cTnI and diastolic BP. Pearson correlation coefficients between systolic BP and log-transformed hs-cTnI were 0.34, 0.34, 0.34, and 0.28 (all $P < 0.0001$) for office, 24-h, daytime, and nighttime systolic BP, respectively.

Multivariable linear regression analyses were consistent with a linear relationship between all systolic BP indices and hs-cTnI, as shown in Table 2. Compared to individuals in the lowest hs-cTnI quartile, those in the highest quartile had an increase in systolic BP of approximately 2 mm Hg after adjustment for other covariates. On a continuous scale, the β-regression coefficients (95% confidence intervals) for log-transformed hs-cTnI levels and systolic office, 24-h, day and nighttime BP were 2.52 (1.24; 3.80), $P = 0.0001$; 2.75 (1.58; 3.91), $P < 0.0001$; 2.71 (1.50; 3.93), $P < 0.0001$, and 2.41 (1.16; 3.65), $P = 0.0002$, respectively. Diastolic BP indices were not associated with hs-cTnI in any of these multivariable analyses (Table 2).

Analyses stratified by physical activity are shown in Table 3. These analyses consistently showed on average stronger associations for the relationship between BP and hs-cTnI among physically less active participants, although the interaction *P* values were not statistically significant.

Table 1. Baseline characteristics according to sex-specific quartiles of high-sensitivity cardiac troponin I

	Quartile 1 (*n* = 517)	Quartile 2 (*n* = 518)	Quartile 3 (*n* = 519)	Quartile 4 (*n* = 518)	
hs-cTnI range, men	**≤0.71 ng/l**	**0.71–0.98, ng/l**	**0.98–1.63, ng/l**	**>1.63, ng/l**	
hs-cTnI range, women	**≤0.33, ng/l**	**0.33–0.47, ng/l**	**0.47–0.71, ng/l**	**>0.71, ng/l**	***P*-value***
Age, years	35 (30;40)	37 (31;40)	37 (32;41)	38 (32;41)	0.002
Sex male (%)	243 (47.0)	244 (47.1)	244 (47.0)	244 (47.1)	—
BMI, kg/m^2	23.4 (21.2; 26.5)	24.5 (22.2; 27.0)	24.6 (22.1; 27.5)	23.9 (22.0; 26.5)	<0.0001
Smoking (%)					0.001
Never	255 (49.3)	277 (53.5)	283 (54.5)	308 (59.5)	
Current	140 (27.1)	124 (23.9)	112 (21.6)	81 (15.6)	
Past	120 (23.2)	116 (22.4)	124 (23.9)	129 (24.9)	
Physical activity (%)	212 (41.0)	252 (48.7)	268 (51.6)	295 (57.0)	<0.0001
Alcohol consumption, g/d	0.64 (0.00; 1.80)	0.00 (0.00; 1.71)	0.64 (0.00; 1.71)	0.64 (0.00; 2.01)	0.25
Antihypertensive TRT (%)	5 (1.0)	8 (1.6)	9 (1.7)	12 (2.3)	0.40
LDL-C, mmol/l	2.9 (2.3; 3.5)	2.9 (2.4; 3.5)	3.0 (2.4; 3.6)	2.8 (2.4; 3.4)	0.08
HDL-C, mmol/l	1.5 (1.2; 1.8)	1.5 (1.2; 1.8)	1.5 (1.2; 1.8)	1.6 (1.3; 1.9)	0.002
Hemoglobin A1c (%)	5.4 (5.2; 5.6)	5.4 (5.2; 5.7)	5.4 (5.2; 5.6)	5.4 (5.2; 5.6)	0.99
eGFR (ml/min/1.73m^2)	112.6 (105.3; 119.6)	112.8 (106.4; 118.5)	111.7 (102.6; 117.7)	110.3 (99.3; 116.6)	<0.0001
Creatinine μmol/l	66.3 (56.6; 76.0)	66.3 (58.3; 76.0)	68.0 (58.3; 76.9)	69.0 (58.3; 78.7)	0.01

Data are median (interquartile range) or number (percentage).

Abbreviations: BMI, body mass index; HDL-C, high density lipoprotein cholesterol; hs-cTnI, high sensitivity cardiac Troponin I; LDL-C, low density lipoprotein cholesterol; GFR, glomerular filtration rate; TRT, treatment.

**P*-values were based on Kruskal–Wallis or chi square tests, as appropriate.

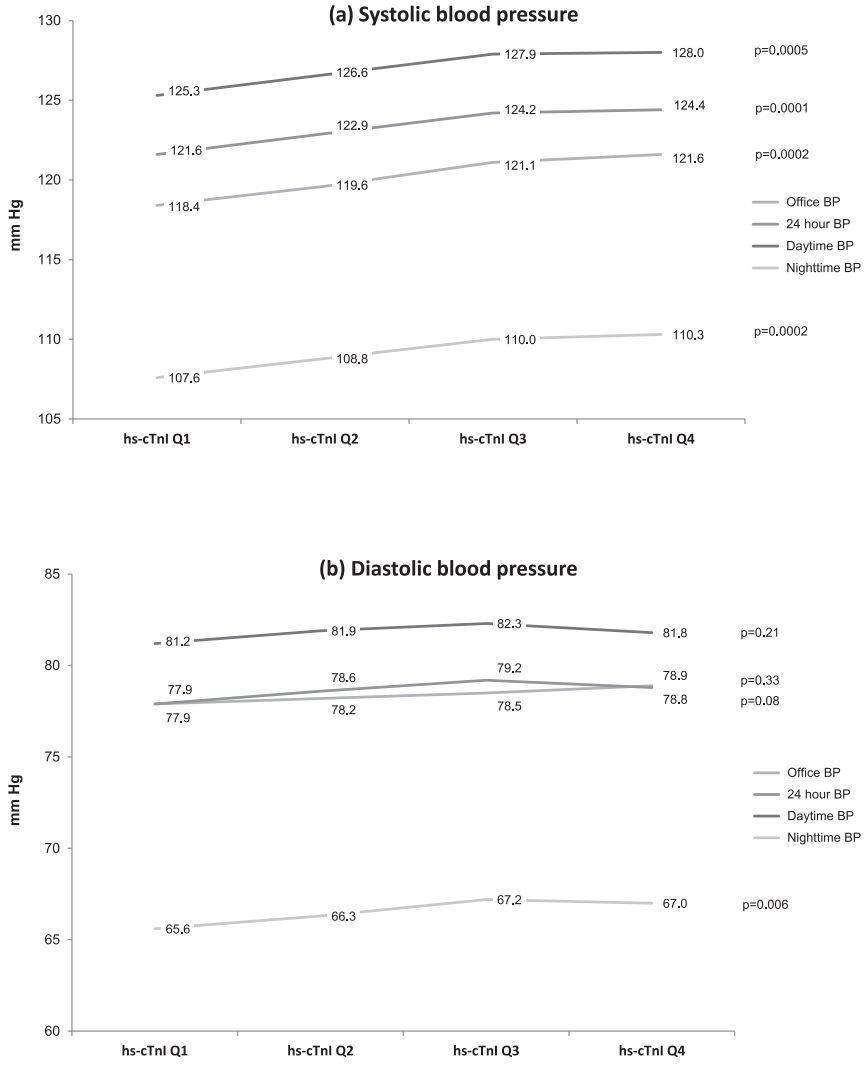

Figure 1. Mean (a) systolic and (b) diastolic BP levels by quartiles of high-sensitivity cardiac troponin I. Values represent mean BP values (in mm Hg) across sex-specific quartiles of high-sensitivity cardiac troponin I. *P* values are based on analysis of variance (ANOVA). Abbreviations: BP, Blood pressure; hs-cTnI, high sensitivity cardiac troponin I; Q, Quartile.

Left ventricular hypertrophy and high-sensitivity cTnI

Left ventricular hypertrophy according to the SLI criteria was present among 267 (13.0 %) individuals. The prevalence of left ventricular hypertrophy across quartiles of hs-cTnI was 11.1, 11.1, 13.4, and 16.3% (*P* for trend = 0.04). Multivariable adjusted odds ratios (95% confidence intervals) across hs-cTnI quartiles were 1.00 (reference), 1.06 (0.69; 1.63), 1.57 (1.03; 2.39), and 1.83 (1.20; 2.77) (*P* for trend = 0.02), as shown in Table 4. Consistent results were observed in analyses stratified by physical activity. Accordingly, none of the *P* values for interaction were statistically significant (data not shown).

DISCUSSION

In this large population-based study of young and healthy adults without prior cardiovascular disease, we observed several important and novel findings. First, using a new highly sensitive (hs) assay, we were able to detect hs-cTnI levels in virtually all participants. Only eleven of 2,072 (0.5%) individuals had undetectable hs-cTnI levels in our sample population. This prevalence of undetectable cTn levels is lower than in most contemporary hs-cTn assays,[12–14] although a previous study has suggested that several other hs-cTnI assays probably have a similar detection rate of over 80%.[11] These data indicate that using the appropriate assay, cTn can now be used as a truly quantitative, continuous parameter even in healthy, low risk populations.

Second, the 99th percentile of hs-cTnI was 15.76 ng/L in men and 6.06 ng/L in women, which is similar to another study using the same hs-cTnI assay.[21] The 99th percentile is an important parameter in the current definition of myocardial infarction,[22] and the skewed distribution in the current study using the most sensitive troponin assay suggests that this parameter will still be useful in the future.[23]

Table 2. Multivariable linear regression analyses for the relationship between blood pressure and high-sensitivity cardiac troponin I

	Continuous (n = 2072)[a]	Quartile 1 (n = 517)	Quartile 2 (n = 518)	Quartile 3 (n = 519)	Quartile 4 (n = 518)	P for trend[b]
Systolic BP						
Office BP	2.52 (1.24; 3.80)**	Reference	0.21 (−1.00; 1.43)	1.42 (0.20; 2.64)	2.35 (1.11; 3.58)	0.0007
24-hour BP	2.75 (1.58; 3.91)**	Reference	0.67 (−0.44; 1.78)	1.88 (0.77; 3.00)	2.47 (1.34; 3.60)	0.002
Daytime BP	2.71 (1.50; 3.93)**	Reference	0.74 (−0.42; 1.90)	1.89 (0.73; 3.06)	2.34 (1.16; 3.52)	0.01
Nighttime BP	2.41 (1.16; 3.65)**	Reference	0.44 (−0.75; 1.63)	1.53 (0.33; 2.72)	2.29 (1.09; 3.50)	0.002
Diastolic BP						
Office BP	0.47 (−0.50; 1.45)	Reference	−0.35 (−1.28; 0.58)	−0.27 (−1.21; 0.66)	0.37 (−0.57; 1.32)	0.10
24-hour BP	0.62 (−0.26; 1.49)	Reference	0.13 (−0.70; 0.97)	0.37 (−0.47; 1.21)	0.38 (−0.47; 1.22)	0.41
Daytime BP	0.44 (−0.49; 1.38)	Reference	0.21 (−0.68; 1.10)	0.21 (−0.68; 1.11)	0.16 (−0.74; 1.07)	0.91
Nighttime BP	0.95 (0.05; 1.85)*	Reference	0.07 (−0.79; 0.93)	0.70 (−0.17; 1.56)	0.70 (−0.18; 1.57)	0.08

Data are β (95% confidence intervals). All coefficients are adjusted for sex, age, body mass index, current smoking, low density lipoprotein cholesterol, high density lipoprotein cholesterol, hemoglobin A1c, glomerular filtration rate, antihypertensive treatment, and physical activity.

[a]Log-transformed variable.

[b]P for trend across quartiles of high-sensitivity Troponin I.

Abbreviation: BP, blood pressure.

*P < 0.05; **P < 0.01.

Table 3. Multivariable linear regression analyses for the relationship between blood pressure and high-sensitivity cardiac troponin I stratified by physical activity

Variable	Physical activity[a]	β (95% confidence intervals)	P-value	P for interaction
Systolic BP				
Office BP	Vigorous	0.93 (−0.85; 2.70)	0.30	0.07
	Usual	4.19 (2.34; 6.04)	<0.0001	
24-hour BP	Vigorous	1.73 (0.12; 3.35)	0.04	0.20
	Usual	3.79 (2.09; 5.48)	<0.0001	
Daytime BP	Vigorous	1.64 (−0.04; 3.32)	0.06	0.18
	Usual	3.85 (2.07; 5.63)	<0.0001	
Nighttime BP	Vigorous	1.91 (0.17; 3.65)	0.03	0.90
	Usual	2.79 (0.99; 4.59)	0.002	
Diastolic BP				
Office BP	Vigorous	0.38 (−1.76; 0.99)	0.58	0.13
	Usual	1.39 (0.001; 2.78)	0.05	
24-hour BP	Vigorous	−0.02 (−1.21; 1.17)	0.97	0.08
	Usual	1.29 (0.002; 2.57)	0.05	
Daytime BP	Vigorous	0.21 (−1.48; 1.07)	0.75	0.08
	Usual	1.15 (−0.22; 2.53)	0.10	
Nighttime BP	Vigorous	0.45 (−0.81; 1.71)	0.48	0.55
	Usual	1.37 (0.07; 2.67)	0.04	

Data are β (95% confidence intervals).

[a]Vigorous physical activity was defined as vigorous activity > 180 minutes per week. All coefficients are adjusted for sex, age, body mass index, current smoking, low density lipoprotein cholesterol, high density lipoprotein cholesterol, hemoglobin A1c, glomerular filtration rate, and antihypertensive treatment.

Abbreviation: BP, Blood pressure.

However, further studies are needed to define the ideal cut-off, given that current hs-cTnI assays are not standardized and the characteristics of the populations studied differ.[11,23] For this reason, it should be highlighted that the clinical significance of hs-cTnI levels above the 99th percentile of this low-risk population is currently unknown. Finally, the

Table 4. Multivariable regression analyses for the relationship between the Sokolow–Lyon Index and high-sensitivity cardiac troponin I

	Continuous (*n* = 2060)	Quartile 1 (*n* = 513)	Quartile 2 (*n* = 516)	Quartile 3 (*n* = 515)	Quartile 4 (*n* = 516)	*P* for trend*
	Sokolow-Lyon Index > 3.5 mV (Logistic regression, OR [95% CI])					
Age-, sex-adjusted model	2.09 (1.40; 3.11)**	Reference	1.01 (0.67; 1.54)	1.36 (0.91; 2.04)	1.83 (1.23; 2.71)	0.005
Fully adjusted model	2.09 (1.37; 3.18)**	Reference	1.06 (0.69; 1.63)	1.57 (1.03; 2.39)	1.83 (1.20; 2.77)	0.02

Fully adjusted model: sex, age, body mass index, current smoking, low density lipoprotein cholesterol, high density lipoprotein cholesterol, hemoglobin A1c, glomerular filtration rate, antihypertensive treatment, physical activity, and nt-pro brain natriuretic peptide. *n* = 12 with missing ECG data.

Abbreviations: OR, odds ratio; CI, confidence intervals.

*P for trend across quartiles of high-sensitivity cardiac Troponin I.

**$P < 0.001$.

marked differences between men and women are also in-line with prior studies and should be taken into account in future definitions.[11,21,24]

Third, using hs-cTnI as a quantitative variable allowed us to detect a significant relationship between hs-cTnI and systolic BP, independent of whether we used conventional or 24-h ambulatory BP indices. The relationship between conventional systolic BP and hs-cTnI has previously been observed in an older population.[25] We are not aware of large studies assessing the relationship between cTn and ambulatory 24-h BP. It is noteworthy that hs-cTnI was also associated with nighttime BP, suggesting that hs-cTnI levels reflect increased myocardial stress associated with an increased overall BP burden. In this context, it is very plausible that hs-cTnI was associated with systolic but not diastolic BP, given that systolic BP is a much more important determinant for cardiac afterload than diastolic BP. In addition, a recent study has found differential effects of systolic and diastolic BP on adverse cardiac outcomes, providing indirect clinical support for our findings.[26] However, it should also be noted that the clinical relevance of small absolute differences of hs-cTn levels within the normal range is currently unknown. Future studies are needed to assess the clinical role of low levels of hs-cTn and the usefulness of their changes over time.

Fourth, hs-cTnI levels were not only associated with systolic BP levels, but also with ECG-determined left ventricular hypertrophy. Individuals with hs-cTnI levels in the highest quartile had an odds ratio for left ventricular hypertrophy of 1.83 (95% confidence interval: 1.20, 2.77; $P = 0.005$) compared to the lowest quartile. This relationship was independent of systolic BP. Our data are in agreement with prior studies,[12,27–29] and suggest that hs-cTnI may become an important tool to rule out left ventricular hypertrophy.[30] Future studies using imaging tools are needed to confirm this hypothesis. In addition, hs-cTnI quantified by the same assay has recently been associated with the occurrence of cardiovascular outcomes in prospective studies, further underscoring its potential value in improving cardiovascular risk stratification.[31,32]

Based on findings of prior studies, we believe that the relationships of hs-cTnI with systolic BP and left ventricular hypertrophy may be explained by the increased amount of cTn in hypertrophic myocardial cells.[33,34] Elevated hs-cTnI levels may also represent subendocardial hypoperfusion or myocardial fibrosis, whose development is supported by high mechanical load.[35,36] This hypothesis is supported by prior studies showing a higher risk of adverse outcomes among individuals with left ventricular hypertrophy on magnetic resonance imaging who also have elevated levels of cTnT and NT-proBNP.[30,37] In our study, the relationship between hs-cTnI and BP seemed to be stronger among individuals with lower levels of physical activity than among those indicating vigorous physical activity, although the *P* value for interaction was not statistically significant. Our data therefore support the concept that hs-cTnI levels mainly reflect BP-induced myocardial hypertrophy among individuals with low to moderate physical activity, while among those with a high level of physical activity, it may be a marker of a physiologically induced increase in left ventricular mass, but not reflecting BP-induced damage.[19,20] An alternative explanation for the elevated hs-cTnI levels among those with vigorous physical activity may be an increased turnover and renewal of cardiomyocytes.[38] Future studies are needed to elucidate in greater detail these relationships.

Strengths and limitations

Major strengths of this study include the population-based study design with a large number of well-characterized young and healthy adults enrolled, and the concomitant recording of both office and 24-h ambulatory BP. Moreover, cTn was measured with a very sensitive assay providing a detection rate of 99.5%. There are some potential limitations that should be taken into account in the interpretation of this study. First, we performed a cross-sectional analysis which does not allow any causal inference. Second, the great majority of enrolled individuals were white, and the generalizability of our results to other population groups is uncertain. However, white women had among the lowest cTn levels in a prior study,[12] suggesting that the assay used should provide similar quantitative results in other ethnic groups as well. Third, although well-validated and specific, ECG-based measures of left ventricular hypertrophy lack sensitivity. We therefore expect even stronger associations in studies where left ventricular mass is measured by imaging. Fourth, hs-cTnI levels may have been influenced by physical activity prior to the blood draw. However, all blood samples were taken in the

fasting state early in the morning, and study nurses instructed participants to avoid intense physical activity the day before study inclusion. Therefore, we believe that the influence of vigorous physical activity on hs-cTnI levels should be minimal. Fifth, our study does not provide any direct clinical implications. However, we believe that our findings improve the understanding of the physiological and pathological underpinnings of cTn levels, which will help to define the clinical role of modern hs-cTnI assays in the future.

CONCLUSION

Using a highly sensitive assay, cTnI levels were detectable in virtually all participants of a young and healthy population, thereby revealing a strong relationship of hs-cTnI with systolic BP. These tests may therefore be useful to directly quantify subclinical myocardial damage associated with elevated BP. Prospective studies are needed to verify these hypotheses.

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DISCLOSURE

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